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From: [redacted]

Project: Ox

25X1A Subject: Visit to [redacted] Regarding V/H Device

25X1A On Friday August 12, 1960 the writer visited the Advanced Systems Engineering Department (ASE) of [redacted] 25X1A
25X1A [redacted] to meet with the following persons:

25X1A [redacted]

Aeroscience Sales
Engineer, Advanced Systems Engineering
Engineer, Advanced Systems Engineering
Department Manager, Advanced Systems Engineering

[redacted] furnished technical information and demonstrated to the writer a V/H detection device breadboard developed by the ASE group.

25X1A The device is an outgrowth of research and development done by GAC on the [redacted] guidance program, and is basically a target tracker which depends upon autocorrelation techniques for tracking, rather than following of a single point or spot target, and views instead an extended area of ground terrain. The principle of operation is implemented by forming an image of the terrain upon a vidicon TV camera tube, storing this image in a TV image storage tube, and then, by switching to a tracking mode, comparing the subsequent images with the first stored image by modulating the scanning, or readout, beam of the storage tube, with the output of the vidicon.

The device demonstrated the tracking functions only, although a proposed means to use this information has been developed by [redacted] and will appear in a proposal document shortly to be issued by them. Copies of this document were requested on an informal basis for our examination and study. 25X1A

With reference to the block diagram of Figure 1, which is essentially a copy of a document exhibited to the writer by [redacted] it will be noted that the correlator closes the loop, during tracking, for both motion along the flight path of the vehicle and for azimuth 25X1A

error due to drift of the vehicle. The output of the correlator box is an error signal which is the second derivative of the position error and must be integrated to obtain the first derivative, or velocity; the output of the integrator has the dimensions of V/H, and is fed to the velocity servo which in turn drives a mirror or prism drive. After each sweep the mirror must be slewed back. This part of the system except the tangent drive, had been breadboarded and was exhibited in operation. V/H output was not available in the breadboard directly. System performance had been measured by photographing with a movie camera a scale mounted above the scene through a telescope which looks through a mirror mounted on the same shaft as the tracking mirror. Data were then reduced by hand plotting the tracking position error. The azimuth portion of the proposed system had not been breadboarded.

The scene viewed by the breadboard was a paper print, stated to have a contrast of 0.8, which was assumed to be the density scale, and had a lineal scale of 2667 feet per inch. The area viewed by the system was stated to be equivalent to a 27,000 foot diameter circle at this scale, since the four inch focal length lens was located 84 inches from the target, and the active photocathode area scanned on the Vidicon was about one-half inch in diameter. The Vidicon used is a type 6198, and the storage tube a Westinghouse WX-4293; a standard 3:4 aspect ratio was used, and the resolution of the system was about 600 lines in the verticle direction, and somewhat better or about 750, in the horizontal direction. (The "ground resolution" was calculated by the writer to be approximately 107 feet, based upon these data.)

The illumination on the target was quite low, and was wholly from ambient room illumination. A fluorescent lamp fixture was ceiling mounted about eight feet over the target, and with the fluorescent tubes perpendicular to it; other fixtures were spaced on either side on approximately ten foot centers. From these data the apparent target brightness can be estimated to be of the order of 5-10 foot-lamberts.

The trigonometry of the V/H problem requires an analog computation. The proposed means for accomplishing this is shown schematically in Figure 2. The servo must turn the pinion by means of the tangent drive rack at the angular rate:

$$\dot{\phi} = \dot{\lambda} \; d \; \sec^2 \lambda$$

in order to keep the tracker on target. The rate ϕ is proportional to V/H by the relation:

$$\frac{V}{h} = \frac{r}{d} \dot{\phi}$$

An error analysis was performed in which the root-sum-squares error was found to be 0.09 per-cent. Analysis of the breadboard performance shows the tracking performance is within 0.13%, if the position data are

converted into average velocity. The rather crude "drag strip" used to move the target is believed a major source of error in this set-up, and in addition, no special gears were used; gear errors would be negligible if large enough gears are used, it was stated.

25X1A It was estimated by [redacted] that the power requirements for a V/H device based upon this principle will be about 40 watts, for a high altitude device, or 50 watts for a low altitude device. By this they mean low versus high V/H ratios respectively; the increase is due to a larger tracking angle required to achieve the desired precision with a higher V/H ratio. A V/H ratio of 0.035 is estimated to require a ±4 degree tracking angle.

The types of power required will be + and - 30 volts, + 300 volts and -100 volts, all of which will be internally converted from available vehicle power, as required.

The volume would be approximately 0.4 cubic foot. Weight was not estimated. In response to a request for an informal estimate of time required to produce a developmental model, [redacted] 25X1A felt that about eight months would be required. Such a unit would meet the definition of a developmental model under MIL-E-5400, and as such would demonstrate operation, but would not necessarily have approved hardware.

The electronics exhibited used mostly silicon transistors in amplifiers and scan circuits, and would present no environmental problems.

The vidicon has a maximum operating temperature of 140°F, and presumably the storage tube is likewise limited in respect to temperature.

The effect of higher temperatures is to evaporate the photo-cathode material and increase the dark current. Photomultipliers contemplated for use in our other equipment will also present a temperature problem.

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According to [redacted] the problem of elevated temperatures on such devices is receiving attention by Westinghouse, but no immediate results seem to be forthcoming. If adequate illumination is available (100-1000 f.c.) [redacted] thinks 25X1A that a more rugged photocathode could be used which might work from 70 - 100°C.

The problem of ground storage temperatures is presently a problem where such devices are used and cooling is not available, or is turned off.

The principal limitation which thus can be foreseen to the GAC device is the temperature sensitivity of the vidicon and image storage tube.

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Further study of the [redacted] proposal will be made when the document is received.

If this device were to be used with a pitching platform, the tracking system could be eliminated and the correlator could simply close the loop to track the platform itself.

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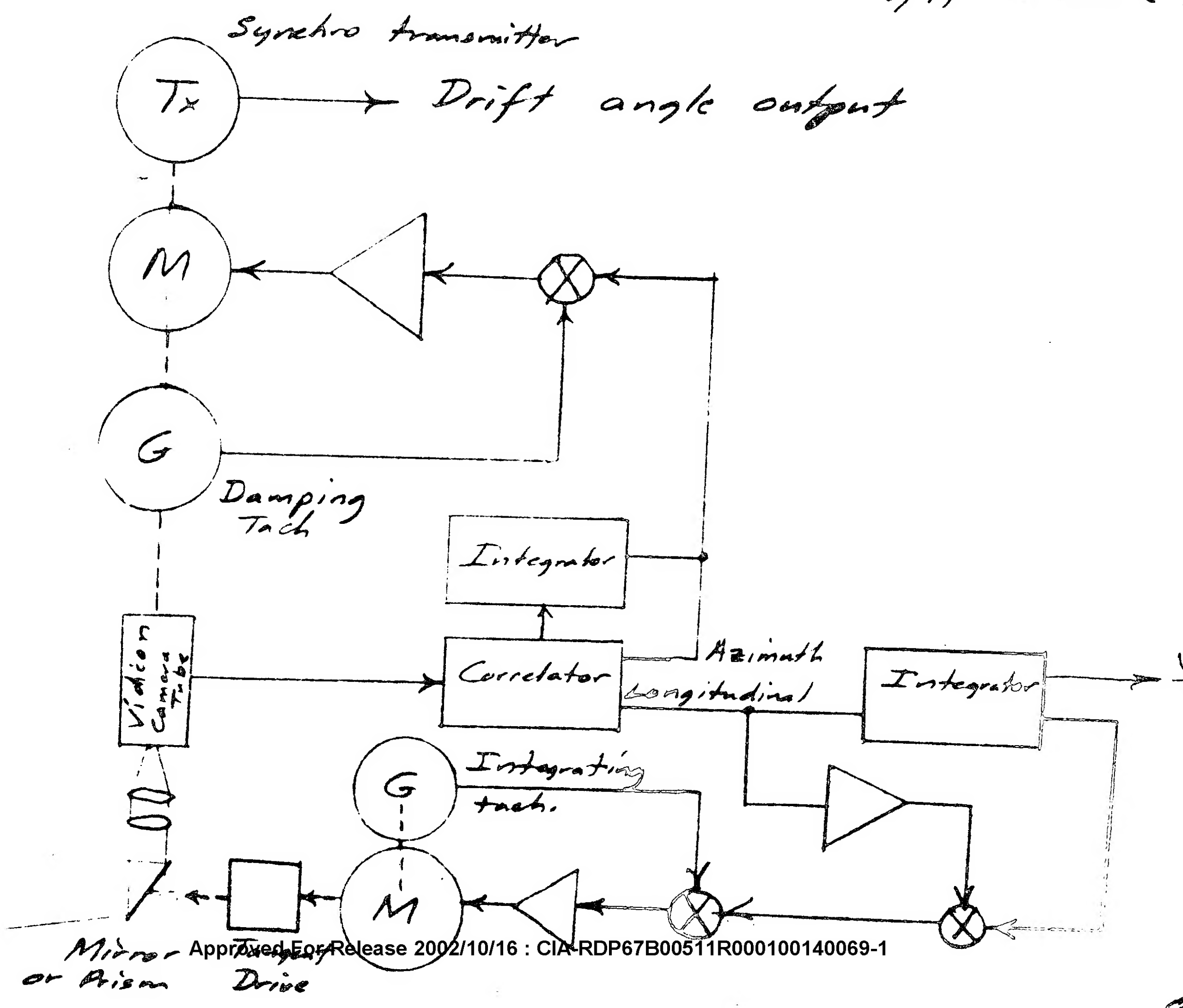
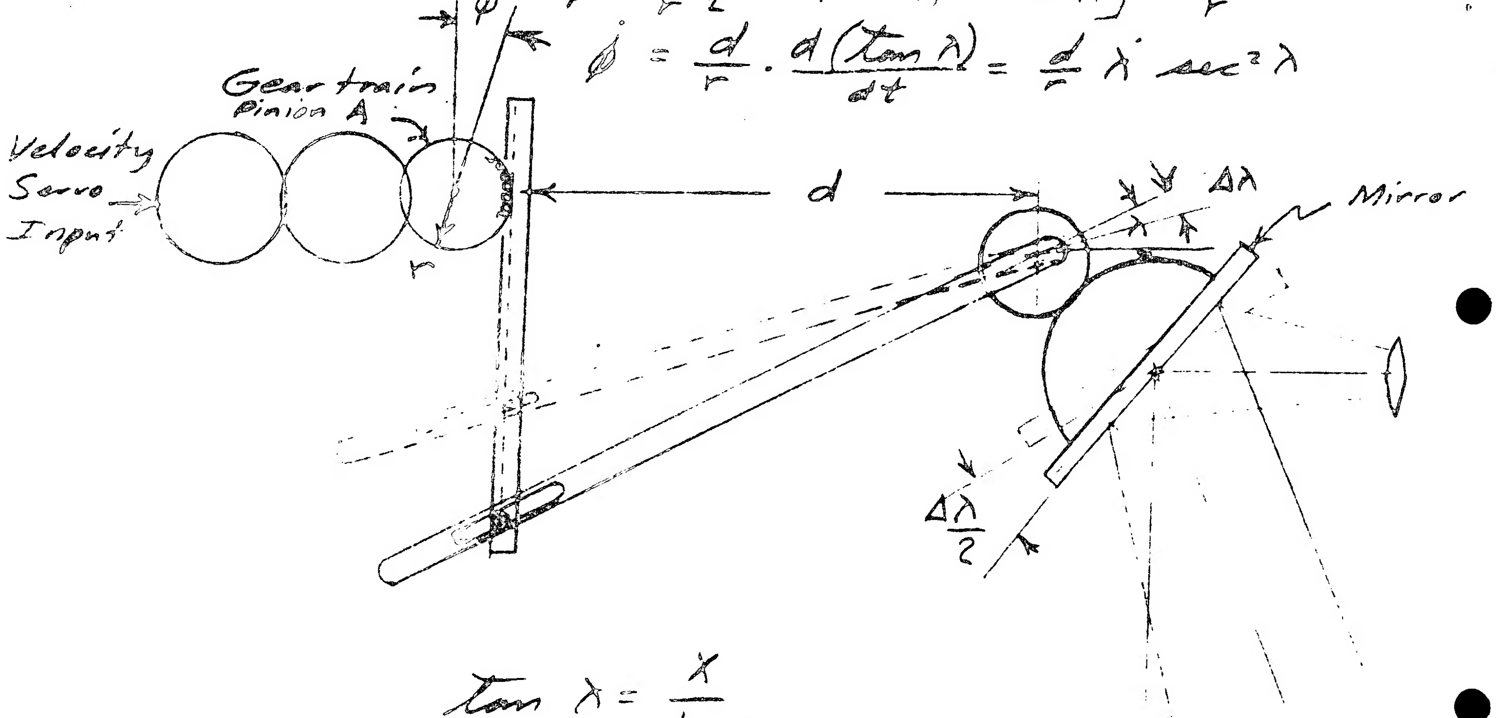
Fig. 1 Block diagram of [redacted] V/H device.



$$\phi = \frac{d}{r}\left[\tan(\lambda + \Delta\lambda) - \tan\lambda\right] = \frac{d}{r}\,\Delta\tan\lambda$$

$$\dot{\phi} = \frac{d}{r}\cdot\frac{d(\tan\lambda)}{dt} = \frac{d}{r}\,\dot{\lambda}\sec^2\lambda$$



$$\tan\lambda = \frac{x}{h}$$

$$\dot{\lambda}\sec^2\lambda = \frac{\dot{x}}{h} = \frac{v}{h}$$

$$\therefore\ \frac{v}{h} = \frac{r}{d}\,\dot{\phi}$$

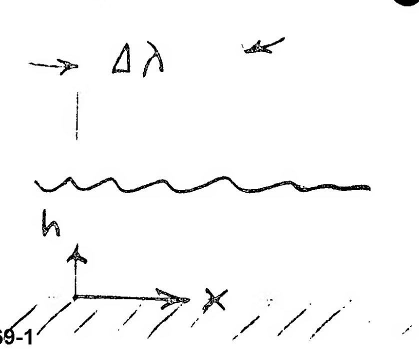


Fig. 2. Schematic of tangent drive for 6AC [illegible]

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